

[Madden Julian Oscillation - the Maritime Continent barrier and seamless verification]

Final Report

1. General Information

Project Title: Madden Julian Oscillation - the Maritime Continent barrier and seamless verification

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2. Main goals of the project, as outlined in the funded proposal

- Explore the relationship between the MJO and the model climatology, the diurnal cycle.
- Perform “seamless” verification approach improve understanding of MJO propagation over the MC and assess the quality of the MJO forecast.
- Examine the MJO precursor signals in the S2S models and their relation to model biases in the MJO forecast.

3. Results and accomplishments

(1) Wang et al (2017) examined observations and forecasts of precipitation over the California in the S2S dataset during the winter seasons of 2016 and 2017. Our analysis of California precipitation during the 2015-16 using the S2S dataset shows that, while the suppressed rainfall in southern California during February 2016 was likely atmospheric “noise” from the point of view of seasonal-interannual prediction, on the 3-4 week (subseasonal) time scale it became predictable “signal” (Figure 1). Similar noise to signal transition as the prediction time scale approaches to 3-4 weeks also emerges from our analysis of California precipitation during the winter of 2016-2017. Our results provide strong evidence that appropriate spatial and temporal average can extend useful forecast to the subseasonal time horizon.

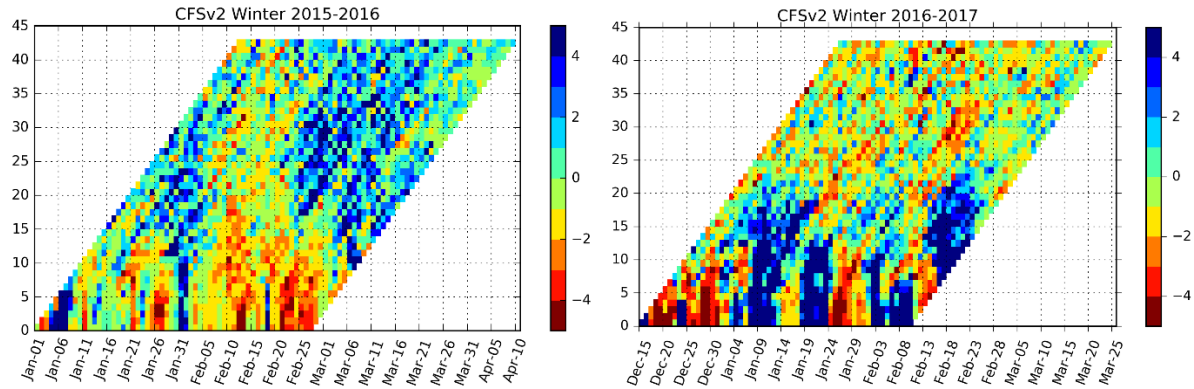


Figure 1. Subseasonal forecast of precipitation anomalies (mm/day) over the California region from the NCEP CFSv2 daily ensemble forecast as a function of initial forecast, and forecast lead times (days) during the winters 2015/2016 and 2016/2017. Skillful intraseasonal prediction of precipitation anomalies is visible in these Chiclet diagrams for these 2 high impact extreme events.

(2). Wang et al. (2018) systematically evaluated MJO/BSISO indices for both boreal winter and summer. Our results indicate the MJO OMI index (Kiladis 2014) is the best in representing propagation of OLR anomalies. The results are published in as “Propagation characteristics of BSISO indices” in Geophysical Research Letters. This study serves to clarify what index should be used for the BSISO.

(3) We applied the OMI index to 10 S2S models’ reforecast datasets. This allowed us to evaluate the MJO convection prediction, which was the first time it has been done. We have shown that the ROMI index is more predictable than the widely used MJO RMM index, therefore it is more suitable for operational use. With the OMI metric, we were able to (1) assess the MJO in both boreal winter and summer seasons (e.g., Fig. 2); (2) identify that many models have substantial difficulty in predicting the MJO over and after its passage of the Maritime Continent at various leads. These results are published in Wang et al. 2019a, Climate Dynamics. The results also stimulated the MJO OMI index for subseasonal prediction of tropical cyclones (Lee et al. 2020). The S2S ROMI data is distributed at the S2S MAPP task force’s webpage:

<https://mapps2s.atmos.colostate.edu/wiki/Main/Diagnostics>.

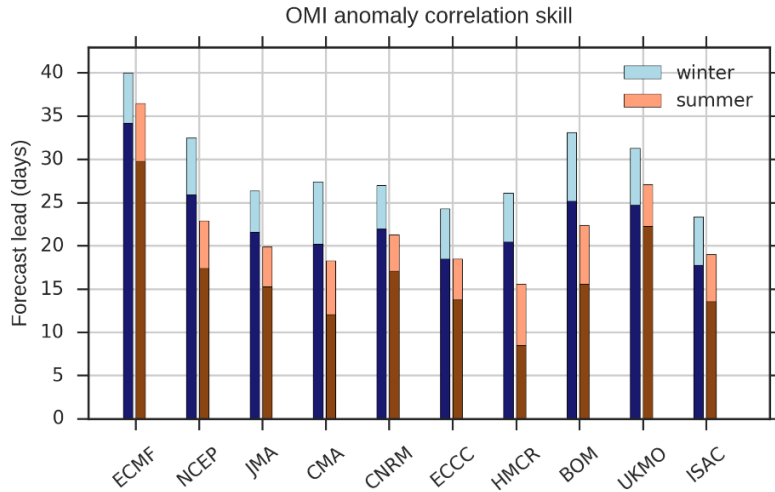


Figure 2. (a). OMI correlation skill score for anomaly correlation coefficient = 0.5 and 0.6 in boreal winter and summer seasons.

(4). We have examined the impact of the QBO on the prediction skill of tropical intraseasonal convection (including the MJO and BSISO) in the 10 forecast models of the WMO/S2S reforecast datasets. The major findings are: (1). MJO prediction skill higher by 5-10 days in QBO easterly than QBO westerly in the WMO/S2S models. (2) Model forecasted stratosphere has little influence in MJO prediction (3). BSISO prediction skill higher in QBO westerly in 1999-2010 due to decadal variability of BSISO. The results was published in Journal of Geophysical Research – Atmosphere. (Wang et al. 2019b).

(5). We have developed python scripts to compute the ROMI in real-time based on the S2S forecasts from the NOAA’s SubX experiment (Pegion et al. 2019: The Subseasonal Experiment (SubX): A multi-model subseasonal prediction Experiment).

We have made the MJO ROMI forecast from the SubX models available for public at our webpage: http://silence.appmath.columbia.edu/romi_realtime_forecasts/

In collaboration with Andrew Robertson at IRI/Columbia University, we are able to publish our realtime OMI prediction at the IRI/SubX webpages:

<http://iridl.ldeo.columbia.edu/SOURCES/Models/.SubX/.EMC/.GEFS/.forecast/.ROMI/>
<http://iridl.ldeo.columbia.edu/SOURCES/Models/.SubX/.ESRL/.FIMr1p1/.forecast/.ROMI/>
http://iridl.ldeo.columbia.edu/SOURCES/Models/.SubX/.GMAO/.GEOS_V2p1/.forecast/.ROMI/
<http://iridl.ldeo.columbia.edu/SOURCES/Models/.SubX/.NCEP/.CFSv2/.forecast/.ROMI/>
<http://iridl.ldeo.columbia.edu/SOURCES/Models/.SubX/.NRL/.NESM/.forecast/.ROMI/>
<http://iridl.ldeo.columbia.edu/SOURCES/Models/.SubX/.RSMAS/.CCSM4/.forecast/.ROMI/>

4. Highlights of Accomplishments

See discussion from Section 3.

5. Transitions to Applications

None to report.

6. Publications from the Project

- Wang, S., A. Anichowski, M. Tippett and A. H. Sobel, 2017: Seasonal noise vs. subseasonal signal: forecasts of California precipitation during the unusual winters of 2015-16 and 2016-17. *Geophysical Research Letter.* 44. <https://doi.org/10.1002/2017GL075052>
- Robertson, A., S. Camargo, A. Sobel, F. Vitart and S. Wang. 2017: Summary of Workshop on Sub-Seasonal to Seasonal Predictability of Extreme Weather and Climate. *NPJ Climate and Atmospheric Science*, 1. 8. <https://doi.org/10.1038/s41612-017-0009-1>
- Ling, J., Zhang, C., Wang, S., and Li, C. (2017), A new interpretation of the ability of global models to simulate the MJO, *Geophys. Res. Lett.*, 44, 5798– 5806, doi:10.1002/2017GL073891.
- Wang, S., Ma, D., Sobel, A. H., & Tippett, M. K. (2018). Propagation characteristics of BSISO indices. *Geophysical Research Letters*, 45, 9934– 9943. <https://doi.org/10.1029/2018GL078321>
- Wang, S., A. H. Sobel, M. K. Tippett, and F. Vitart. 2019a. Prediction and predictability of tropical intraseasonal convection: seasonal dependence and the Maritime Continent prediction barrier. *Climate Dynamics*. <https://doi.org/10.1007/s00382-018-4492-9>
- Wang, S., M. K. Tippett, A.H Sobel, Z. Martin, and F. Vitart. Impact of the QBO on prediction and predictability of the MJO convection. *J. Geophys. Res. Atmospheres*, 2019b. , 124, 11766– 11782. <https://doi.org/10.1029/2019JD030575>
- Lee, C., S.J. Camargo, F. Vitart, A.H. Sobel, J. Camp, S. Wang, M.K. Tippett, and Q. Yang, 2020: Subseasonal Predictions of Tropical Cyclone Occurrence and ACE in the S2S Dataset. *Wea. Forecasting*, 35, 921–938, <https://doi.org/10.1175/WAF-D-19-0217.1>

Conference and workshop presentations:

None to report

7. PI Contact Information

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8. Budget for Coming Year

None to report

9. Future Work

None to report